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**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
APPLICATION FOR UNITED STATES LETTERS PATENT**

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TITLE: **TRANSFER TAPE**

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TRANSFER TAPE

RELATED APPLICATIONS

[0001] This application is a continuation application of International Application PCT/JP02/08848, that has an international filing date of August 30, 2002, claiming priority under § 365(b) to Japanese Application 2001-305412 filed on October 1, 2001. This continuation application fully incorporates the above applications by reference and further claims priority to the Japanese Application 2001-305412 filing date of October 1, 2001 under § 119(a)-(d).

BACKGROUND

1. Technical Field

[0002] The present invention relates to transfer tape that has an adhesive film formed by coating a band-shaped ribbon with an adhesive film transfers the adhesive film from the band-shaped ribbon to a targeted object, thereby adhering the targeted object to another adhering object by means of the adhesive film transferred to said targeted object, and more particularly to transfer tape that maintains strong adhesive strength but can be reliably cut at a stipulated position.

2. Technical Background

[0003] A transfer tool using transfer tape that has an adhesive film formed by coating a band-shaped ribbon with an adhesive film transfers the adhesive film from the band-shaped ribbon to a targeted object, thereby adhering the targeted object to another adhering object by means of the adhesive film transferred to said targeted object. This type of transfer tool is provided with: a supply spool around which is wound the unused transfer tape; a take-up spool that takes up the band-shaped ribbon after the adhesive film is transferred; and a dispenser that is provided in an intermediate location upon the transport path between the supply spool and take-up spool and exposed to the outside.

[0004] A transfer tool of the constitution described above is used by pressing the dispenser onto the targeted object, moving the entire tool in this state, thereby

transferring the adhesive film onto the targeted object and separating the transfer tool (entire tool) from the targeted object at a desired location. The adhesive film upon the band-shaped ribbon is thus cut at the dispenser onto the side on the targeted object and the side on the transfer tape.

[0005] In this operation of the transfer tool, in recent years the ease of cutting the adhesive film is considered important from the standpoint of ease of use. To wit, the adhesive film adheres the targeted object to the other adhering object so naturally it has adhesive strength. But if this adhesive strength is too high, the adhesive film cannot be easily cut when one attempts to cut it at the desired location, but rather it is stretched out in strings between the side of the targeted object and the side of the band-shaped ribbon (this phenomenon shall hereinafter be referred to as "stringiness").

[0006] When this stringiness occurs, in the case that the terminus of the stringiness is present on the side of the targeted object, for example, dumpling-like lumps may occur when the terminuses of the stringiness are concentrated on the targeted object, or a step may occur in the state of adhesion between the targeted object and the adhering object, or gaps may occur so that good adhesion is not achieved. On the other hand, in the same manner, in the case that the terminus of the stringiness is present on the side of the band-shaped ribbon, for example, when it is used next, the dumpling-like lumps may be transferred to the targeted object or there may be occasional cases in which the transfer of the adhesive film cannot be started from the desired position. Moreover, there is a risk of the adhesive film adhering to the dispenser itself and having deleterious effects on its operation.

[0007] To solve this problem and prevent the stringiness as described above from occurring, JP-A 2000-98233 proposes providing a plurality of protrusions on the adhesive film side of the band-shaped ribbon such that they protrude in both width directions of said band-shaped ribbon, so that these protrusions make the adhesive film partially thinner. In addition, JP-A 2001-192625 proposes a pressure-sensitive transfer type adhesive tape wherein the adhesive film is disposed upon the band-shaped ribbon in a state in which it is cut to units of a stipulated size.

[0008] However, even if these proposals suppress stringiness, the adhesive film can only be cut at the positions of the predetermined protrusions or to the units of a stipulated size, so it cannot be cut at the desired positions (of size or length). In addition, there are problems in that this increases cost due to the difficulty of manufacturing special band-shaped ribbon, and the need for facilities for coating the band-shaped ribbon with a coating cut into stipulated units.

[0009] In order to allow the adhesive film to be easily cut at the desired positions while suppressing stringiness easily and at low cost, in the past, JP-B 6-62920 proposed adhesive transfer tape wherein alginic acid is finely dispersed within an aqueous dispersal solution of the adhesive, thereby weakening the membranous character of the adhesive film and allowing it to be cut easily. In addition, JP-A 2001-240812, for example, proposes pressure-sensitive transfer adhesive tape wherein: the adhesive film contains a filler, the equation (thickness of the adhesive film)/(filler grain size) = 0.6-8.0 is true, and the thickness of the adhesive film is 5-200 µm.

[0010] However, in the ones containing filler proposed in the aforementioned JP-A 2001-240812, the filler is spherical so the effect of allowing the film of the adhesive film cannot be reliably obtained, so there is a problem in that the cutting effect may not be obtained depending on the film thickness. In addition, there is also a problem in that, while the amount of filler can be easily increased or the thickness of the adhesive film can be easily made thinner, the adhesive strength conversely decreases.

[0011] In addition, with the adhesive transfer tape proposed in JP-B 6-62920, the membranous character of the adhesive film is weakened so it is easily cut, its adhesive strength may be extremely reduced due to inadequate dispersion of the alginic acid, or it may be cut at unnecessary locations, so the cutting effect cannot be reliably obtained over the entire adhesive film.

[0012] The present invention came about in order to solve the aforementioned problems and has as its object to provide transfer tape that maintains strong adhesive strength but can be reliably cut at a stipulated position.

SUMMARY OF THE INVENTION

[0013] The present invention came about based on the following reasons.

[0014] To wit, the conventional fillers had as their object to weaken (disrupt) the viscosity among the principal components of the adhesive film (membranous character of the adhesive film), and thereby lower the overall adhesive strength and simplify its cutting. Accordingly, the conventional filler had been spherical (cutting due to the filler had not been noted), so as a result the adhesive strength had been lowered at the same time that cutting is simplified.

[0015] The present invention differs from the prior art in that it does not lower the overall adhesive strength, but rather when increasing the viscosity among the main components of the adhesive film and strengthening the overall adhesive strength, it actively improves the cutting of the film of the adhesive film. As a result, the adhesive film contains needle-shaped or preferably steeple-shaped (a shape with a sharpened end) particles.

[0016] In addition, the needle-shaped particles in this Application are defined to be preferably steeple-shaped as described above. But they may also be pillar-shaped in which the ratio of the maximum grain diameter to the length of the particle is 1:3 or more to give it a rod-like shape, if not spherical , and the particles shaped as such preferably constitute 90% or more of all of the particles.

[0017] As a result, the following effect occurs. When the adhesive strength is increased, the viscosity among the adhesive components is high as described above, so a film that is not easily cut is formed. But because it contains needle-shaped particles, when a force is applied in a direction other than the direction of the plane along which the band-shaped ribbon is coated with the adhesive film, the film of the adhesive film becomes thinner and then the needle-shaped particles rupture the film, thereby cutting the adhesive film. Then, the cut edge of the adhesive film is pulled to the needle-shaped particles, resulting in the film being cut completely without stringiness at the cut edges.

[0018] In passing, appropriate materials to be included in the adhesive film as the needle-shaped particles include, for example, glass, wollastonite, sepiolite,

chrysotile, aluminum borate whiskers, titanium oxide whiskers and potassium titanate whiskers.

[0019] An adhesive film with its adhesive strength increased in this manner is readily transferred from the band-shaped ribbon to the targeted object and strongly adheres the targeted object to the other adhering object. Moreover, by moving the transfer tape in a direction other than in a horizontal plane with respect to the targeted object at the desired position, the needle-shaped particles rupture the film of the adhesive film and reliably cut the adhesive film.

[0020] In addition, in the present invention, the needle-shaped particles as described above also have a Mohs hardness of 6 or greater. The Mohs hardness is one scale for indicating the hardness of a substance, with 10 numbers defined from the softest mineral to the hardest which is diamond. The positions of various minerals are determined on a scale of one to 10 depending on which of the standard minerals they are first scratched by. Informally also called the scratch hardness, the Mohs hardness indicates not the absolute value of the hardness but rather the relative hardness when compared in order. The hardness of the standard minerals are diamond: 10, corundum: 9, topaz: 8, quartz: 7, feldspar: 6, apatite: 5, fluorite: 4, calcite: 3, gypsum: 2 and talc: 1.

[0021] Here, the reason why the Mohs hardness of the needle-shaped particles is set to 6 or greater is that if the Mohs hardness is softer than 6, the needle shape is readily broken at the stage of including the needle-shaped particles into the main components of the adhesive film to manufacture the final transfer tape. Moreover, by including needle-shaped particles with a Mohs hardness of 6 or greater, the film of the adhesive film can be more readily ruptured and the adhesive film can be readily cut.

[0022] In passing, materials that have a Mohs hardness of 6 or greater include, for example, glass, titanium oxide whiskers, and aluminum borate whiskers. By using them, the meritorious effects described above can be more reliably obtained without the needle shape being broken in the process of manufacturing the transfer tape.

[0023] In addition, with the constitution described above, the present invention sets the maximum grain diameter size of the needle-shaped particles to 5-30 μm and the length of the particles to 30-500 μm . The reason for this is that, if the maximum grain diameter is smaller than 5 μm and the particle length is shorter than 30 μm , then the tendency not to contribute to the ease of cutting the adhesive film becomes stronger. If the maximum grain diameter of the needle-shaped particles is larger than 30 μm and the particle length is longer than 500 μm , then the tendency for the needle-shaped particles to become caught in the smoother of the gravure coater or the Meyer bar of the kiss coater, thereby causing streaks in the coating and deleteriously affecting the quality of coating becomes stronger.

[0024] In addition, with the constitution described above, the present invention sets the needle-shaped particle content ratio of the adhesive film composition to 1.0-3.0 wt.%. The reason for this is that, if the needle-shaped particle content is lower than 1.0 wt.%, then cases in which the ease of cutting cannot be maintained stable arise, but if higher than 3.0 wt.%, then cases in which the adhesive strength decreases may arise.

[0025] Note that the following materials may be used as the constituent ingredients of the adhesive film other than the needle-shaped particles. The adhesive used may be acrylic-based, rubber-based or silicone-based, for example. Moreover, if necessary, a rosin-based, terpene-based or other tackifier may also be used. In addition, it is possible to use a colorant such as Phthalocyanine Blue, Phthalocyanine Green, Brilliant Carmine 6B, Permanent Yellow H10G, Lake Red, or another organic pigment which is good from the standpoint of the clarity and fastness of color. In addition, a cissing preventative agent or preservative and the like may be included.

[0026] The material used for the band-shaped ribbon may be polyethylene terephthalate, polyethylene, polypropylene, polyvinyl chloride or other plastic film, or glassine paper or the like. In addition, depending on the case, either one or both sides of the band-shaped ribbon may be treated with a mold-release agent such as a silicone resin or fluororesin.

[0027] Note that the thickness of the band-shaped ribbon is preferably 5-60 µm and particularly preferably 15-55 µm. The reason for this is that if it is thinner than 5 µm, the transfer tape is susceptible to wrinkling or kinking which may cause malfunctioning. On the other hand, if it is thicker than 60 µm, then it is difficult to include longer lengths within the limited space within the transfer tool, the materials cost increases, and it may become resistant to bending, thus causing feed or transfer malfunctions.

[0028] Moreover, the thickness to which the band-shaped ribbon is coated with the adhesive film is preferably 15-30 µm. The reason for this is that if it is thinner than 15 µm, then cases of reduced adhesive strength may occur, but if thicker than 30 µm, then cases in which the ease of cutting cannot be maintained stably may occur. Note that the band-shaped ribbon may be coated with the adhesive film using a kiss coater, gravure coater, comma coater or by other method.

[0029] A transfer tape according to the present invention is used in a transfer tool which is provided with: a supply spool around which is wound the unused transfer tape; a take-up spool that takes up the band-shaped ribbon after the adhesive film is transferred; and a dispenser that is provided in an intermediate location upon the transport path between the supply spool and take-up spool and exposed to the outside.

[0030] The transfer tool is used by pressing the dispenser onto the targeted object, moving the entire tool in this state, thereby transferring the adhesive film onto the targeted object and separating the transfer tool (entire tool) from the targeted object at a desired location. The adhesive film upon the band-shaped ribbon is thus cut at the dispenser by a cutting action of the needle-shaped particles onto the side on the targeted object and the side on the transfer tape.

BRIEF EXPLANATION OF THE DRAWINGS

[0031] FIG. 1 is a table showing the values of the parameters employed in the Working Examples and Comparative Examples, along with evaluations from various tests and overall evaluations.

[0032] FIG. 2 is a table showing the values of the parameters employed in the Working Examples, along with evaluations from various tests and overall evaluations.

DETAILED DESCRIPTION

[0033] Here follows a description of the meritorious effects of the present invention made with reference to FIG. 1 and FIG. 2. In the following, Working Examples 1-11 are modes wherein the present invention is adopted, with FIG. 1 and FIG. 2 illustrating the correspondence between the various Working Examples and the values of the parameters employed in the present invention. In addition, the Comparative Examples are modes wherein the present invention is not adopted. Moreover, Working Examples 1-7 and Comparative Examples 1 and 2 adopt a uniform 1.0 parts by weight as the amount of needle-shaped particles and spherical particles. The values of the other parameters are presented in FIG. 1 and FIG. 2.

[0034] The adhesive coating used in the tests had the following composition:

- Needle-shaped or spherical particles: 1.0 parts by weight (Working Examples 1-7 and Comparative Examples 1 and 2)
- Emulsion-type acrylic adhesive: 37.0 parts by weight (parts by weight when converted to solids)
- Rosin-based tackifier: 4.5 parts by weight (parts by weight when converted to solids)
- Phthalocyanine Blue colorant: 1.5 parts by weight
- Cissing preventative agent: 2.5 parts by weight
- Water: 53.5 parts by weight

[0035] Note that in Working Examples 8-11, only the parts by weight of the needle-shaped or spherical particles was varied as illustrated in FIG. 2, while the other constituent ingredients were kept as the same parts by weight in the formula above.

[0036] Here follows a description of the tests performed in order to confirm the meritorious effects.

(Ease of Coating)

[0037] At the time of manufacture of the transfer tape, a 25 µm polyethylene terephthalate film (band-shaped ribbon) treated with mold-release agent on both sides was coated with an adhesive film according to the various examples described above using a kiss coater to achieve various coating depths. The appearance of the coated surface was evaluated at that time, using the following scale:

- 5: Absolutely no problems from an appearance standpoint.
- 4: Nearly no problems from an appearance standpoint.
- 3: A small amount of cosmetic streaking (but no problems in use).
- 2: A noticeable amount of cosmetic streaking (but no problems in use).
- 1: Marked streaking thought to be due to needle-shaped or spherical particles becoming caught on the Meyer bar of the kiss coater occurred, also causing problems in use.

(Ease of Cutting: Test A)

[0038] A transfer tool with a width of 8.4 mm was used to transfer 10 cm of the adhesive film to high-quality paper (the targeted object) and then the transfer tool was moved in the direction of operation of the transfer tool as is while being lifted at an angle of 30° with respect to the targeted object to cut the adhesive film. This test was performed 10 times on each of the examples, and the number of times stringiness occurred was evaluated using the following scale:

- 5: Stringiness did not occur.
- 4: Stringiness of less than 1 mm occurred 1-2 times.
- 3: Stringiness of less than 1 mm occurred 3-4 times.
- 2: Stringiness of 1 mm or more occurred 1-3 times.
- 1: Stringiness of 1 mm or more occurred 4 or more times.

(Ease of Cutting: Test B)

[0039] A transfer tool with a width of 8.4 mm was used to transfer 10 cm of the adhesive film to high-quality paper (the target object) and then the transfer tool was lifted as is at an angle of 90° with respect to the target object to cut the

adhesive film. This test was performed 10 times on each of the examples, and the number of times stringiness occurred was evaluated , using the following scale:

- 5: Stringiness did not occur.
- 4: Stringiness of less than 1 mm occurred 1-2 times..
- 3: Stringiness of less than 1 mm occurred 3-4 times.
- 2: Stringiness of 1 mm or more occurred 1-3 times.
- 1: Stringiness of 1 mm or more occurred 4 or more times.

(Adhesive Strength)

[0040] A transfer tool with a width of 8.4 mm was used to transfer 10 cm of the adhesive film to high-quality paper (the target object) which was then adhered to high-quality paper of the same quality as the targeted object. A 2-kg roller was rolled back and forth twice to adhere the two and after 3 minutes elapsed, the adhered object was peeled off. The state of the adhered surface of the adhered object was evaluated, using the following scale:

- 5: Entire surface ripped.
- 4: 70% to less than 100% of the entire adhered surface ripped.
- 3: 50% to less than 70% of the entire adhered surface ripped.
- 2: Less than 50% of the entire adhered surface ripped. Or the adhered surface became fuzzy.
- 1: Unchanged from before adhesion.

[0041] FIG. 1 presents a comparison of Working Examples 1-6, wherein the adhesive film contains the needle-shaped particles at between about 1.0 wt.% and about 3.0 wt.% in the constituent ingredients of the adhesive film, while varying the maximum grain diameters between about 5 μm and about 30 μm and the grain lengths between about 30 μm and 500 μm , against Comparative Examples 1 and 2, while illustrating the results of evaluation (with Test A for ease of cutting) and the correspondence with the values of the parameters employed in the present invention. Note that the overall evaluation is indicated by the symbols \odot , \circ , \triangle and \times in order from best to worst, where the numbers in parentheses indicate the totals of the scale numbers given above. In addition, on the parameter rows,

wherein: parameter 1 denotes the adhesive film contains needle-shaped particles; parameter 2 denotes that the Mohs hardness of the needle-shaped particles is 6 or greater; parameter 3 denotes that maximum grain diameter of the needle-shaped particles is 5-30 μm and their grain length is 30-500 μm ; and parameter 4 denotes that the needle-shaped particle content is 1.0-3.0 wt.%, ○ indicates that an Example employs the parameter for parameter 1 or that the value falls within the stipulated parameter range for each of parameters 2, 3 and 4, △ indicates that the value falls within the stipulated range, but the value is closer to the upper or lower limit of the parameter than the center of the range, while × indicates no employment of parameter 1 or that the value falls outside the stipulated range for each of parameters 2, 3 and 4.

[0042] Here follows a description of the results of various Examples in FIG. 1 along with the reasons.

[0043] Comparative Example 1 had an overall evaluation of × (11). The reason why is because the particles were spherical in shape, the evaluation of ease of cutting Test A was poor.

[0044] Comparative Example 2 had an overall evaluation of × (9). The reason why is because the thickness of coating the adhesive film was made thinner than in Comparative Example 1, so the evaluation of ease of cutting Test A was improved over that of Comparative Example 1, but the evaluation of adhesive strength was worse.

[0045] Working Example 1 had an overall evaluation of △ (12). The reason why is because wollastonite with a Mohs hardness of 4.5 was used for the needle-shaped particles, and the maximum grain size and particle length of the needle-shaped particles (hereinafter called the “particle dimensions”) was outside the lower limits, so the evaluation of ease of cutting Test A was low. However, needle-shaped particles were used, so the results were better overall than those of Comparative Examples 1 and 2.

[0046] Working Example 2 had an overall evaluation of ○ (13) so the results were better than those of Working Example 1. The reason why is because,

although the Mohs hardness was outside the lower limit, the particle dimensions were the lower limit values within the range, so the evaluation of ease of cutting Test A was improved. In addition, needle-shaped particles were used, so the results were better overall than those of Comparative Examples 1 and 2.

[0047] Working Examples 3 and 4 had overall evaluations of \odot (14) so the results were the best of all of the examples shown in FIG. 1. The reason why is because, although the Mohs hardness was outside the lower limit, the particle dimensions were within the range, so the evaluation of ease of cutting Test A was improved.

[0048] Working Example 5 had an overall evaluation of \circ (13) so the results were slightly worse than those of Working Examples 3 and 4. The reason why is because the particle dimensions were values near the upper limits within the range, so the evaluation of ease of coating was slightly lower in comparison to Working Examples 3 and 4. In addition, needle-shaped particles were used, so the results were better overall than those of Comparative Examples 1 and 2.

[0049] Working Example 6 had an overall evaluation of \triangle (12) so the results were slightly worse than those of Working Examples 3 and 4. The reason why is because the particle dimensions exceeded the upper limits, so the evaluation of ease of coating was lower in comparison to Working Examples 3 and 4. In addition, needle-shaped particles were used, so the results were better overall than those of Comparative Examples 1 and 2.

[0050] An overall summary of the various Examples presented in FIG. 1 was given above, where Working Examples 1-6 which contained needle-shaped particles gave results that were better overall than those of Comparative Examples 1 and 2 which did not adopt the present invention at all. Moreover, in Working Examples 1-6, it was found that the overall evaluation was increased when the maximum grain diameter of the needle-shaped particles is 5-30 μm and the grain length of the particles is 30-500 μm .

[0051] FIG. 2 presents the results of evaluation (with Test B for ease of cutting) of Working Example 4 which had the best overall results in FIG. 1 and

Working Examples 7-11 wherein the adhesive film contains the needle-shaped particles whose Mohs harness was 6 or greater, maximum grain diameters were between about 5 μm and about 30 μm , and grain lengths were between about 30 μm and 500 μm , while varying their content ratio at between about 1.0 wt.% and about 3.0 wt.% in the constituent ingredients of the adhesive film. Accordingly, in Working Examples 8-11 among Working Examples 7-11, the amount of needle-shaped particles was varied to the values of 0.3, 0.5, 1.4 and 1.7 parts by weight, thus varying the content ratio. Note that the overall evaluation is indicated by the symbols \odot , \circ , \triangle and \times in order from best to worst, where the numbers in parentheses indicate the totals of the scale numbers given above. The parameter rows show the evaluation results of the Examples evaluated, using the same evaluation methods used in FIG. 1.

[0052] Here follows a description of the results of various Examples in FIG. 2 along with the reasons.

[0053] Working Example 4 had an overall evaluation of \triangle (12). The reason why is because the Mohs hardness was outside the lower limit, so the evaluation of ease of cutting Test B was poor. Note that in the following, the evaluation of relative superiority is indicated based on Working Example 4 in FIG. 2 as the reference, but all exhibited results better than Comparative Examples 1 and 2 shown in FIG. 1.

[0054] Working Example 7 had an overall evaluation of \odot (15) so the results were the best of all of the examples shown in FIG. 1 or FIG 2. The reason why is because the requirement of a Mohs hardness of 6 or greater was satisfied, so the evaluation of ease of cutting Test B was improved in comparison to Working Example 4, and also all of the stipulations of the present invention were satisfied.

[0055] Working Example 8 had an overall evaluation of \circ (13) so the results were worse than those of Working Example 7 but better than those of Working Example 4. The reason why is because the particle content ratio was outside the lower limit, so the evaluation of ease of cutting Test B was low.

[0056] Working Example 9 had an overall evaluation of ○ (14) so the results were slightly worse than those of Working Example 7 but better than those of Working Example 8. The reason why is because the particle content ratio was at the lower limit within the range, so the evaluation of ease of cutting Test B was improved over that of Working Example 8.

[0057] Working Example 10 had an overall evaluation of ○ (14) so the results were slightly worse than those of Working Example 7 but roughly the same as those of Working Example 9. The reason why is because the particle content ratio was at the upper limit within the range, so the evaluation of ease of cutting Test B was improved over that of Working Example 9 but the adhesive strength was lower than that of Working Example 9.

[0058] Working Example 11 had an overall evaluation of ○ (13) so the results were worse than those of Working Example 7 but better than those of Working Example 4. The reason why is because the particle content ratio exceeded the upper limit, so the adhesive strength was low.

[0059] An overall summary of the various Examples presented in FIG. 2 was given above, where Working Examples 7-11, wherein the adhesive film contained the needle-shaped particles whose Mohs harness was 6 or greater, maximum grain diameters were between about 5 μm and about 30 μm , and grain lengths were between about 30 μm and 500 μm , while varying their content ratio at between about 1.0 wt.% and about 3.0 wt.% in the constituent ingredients of the adhesive film, gave results that were better overall than those of Working Example 4 , wherein the Mohs hardness of the contained particles was less than 6. Working Examples 7-11, in which a Mohs hardness of 6 or greater were used, exhibited good results regarding the ease of cutting. Also, Working Examples 7, 9 and 10 exhibited good results compared against Working Examples 8 and 11 because Working Examples 7, 9 and 10 contained the needle-shaped particles at a content ratio of 1.0-3.0 wt.%, particularly.

[0060] As described above, the transfer tape according to the present invention has an adhesive film that contains needle-shaped particles, whose Mohs hardness is 6 or greater, at a content ratio of 1.0-3.0 wt.%, so it maintains strong adhesive strength but the adhesive film can be reliably cut at a stipulated position without generating stringiness. Moreover, even if the adhesive strength is increased, by adopting needle-shaped particles with a maximum grain diameter of 5-30 μm and a particle length of 30-500 μm , , the aforementioned meritorious effects can be obtained and also they become even more marked.